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The Effectiveness of Online Collaboration Tools for Researchers in Poor Resource Settings: A Study of Researchers in Selected University Communities in Nigeria

Margaret Offoboche Agada-Mba

School of Media and Communication, Pan Atlantic University, Nigeria

https://orcid.org/0000-0003-4838-8019

Maiyekogbon Toluwalashe

Livability, Bournemouth, United Kingdom

https://orcid.org/0009-0001-4426-6316

Melugbo Doris Ujunwa

Centre for Entrepreneurship and Development Research, University of Nigeria Nsukka

https://orcid.org/0000-0002-4284-9112

Otadaferua Bettina Oboakore

Mass Communication, University of Nigeria Nsukka

https://orcid.org/0009-0008-0736-6992

&

***Jemisenia Oluwaseyi John**

Sociology and Anthropology, University of Nigeria Nsukka

***Corresponding author email: john.jemisenia@gmail.com**

https://orcid.org/0000-0002-2134-6866

Abstract

Background: Collaboration among researchers is crucial for scientific progress. However, academics in developing countries like Nigeria continue to face structural and personal barriers to effectively utilising online collaborative tools. While there is much hope that researchers in this part of the globe will continue to maximise the opportunities presented within the online collaborative space, the effectiveness of these tools in supporting collaborative research activities in poor resource areas lacks significant study focus.

Objective: The study investigated the effectiveness of online collaboration tools among researchers in some university communities in Nigeria.

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Methodology: The research adopted an online survey method to gather data from 312 academics/researchers across some universities in Nigeria who were selected using purposive and chain-referral sampling approaches.

Results: Findings showed a high preference for many of the platforms presented to respondents, with Google Scholar being the most frequently used, followed by Mendeley and Zotero. Findings found common challenges that researchers face when using these online collaborative tools: limited access to Internet services, software compatibility issues, training and skill deficiency, data security concerns, absence of institutional support, high cost of software subscription plan, and difficulties using/managing different tools/platforms. In addition, findings revealed that the level of engagement, as defined by heavy use and non-heavy use, impacted the perceived effectiveness of these tools. Specifically, heavy usage had a greater impact on perceived effectiveness than non-heavy usage. Results also showed significant variances across various platform types regarding perceived effectiveness. Specifically, Mendeley was found to be mostly effective compared to other platforms. Finally, a regression analysis showed the influence of user group, age and frequency of using tools on perceived effectiveness.

Contribution: The study adds to existing knowledge concerning the utilisation of and barriers to the effectiveness of adopting these online collaborative platforms, particularly within the contexts of Nigerian universities.

Conclusion: Overall, the current research highlights the significance of developing evidence-based strategies to address the key barriers to effective online collaborative tool utilisation among Nigerian researchers and in places that share similar challenges with the present context.

Recommendation: Specific or customised interventions should be developed to address challenges researchers face in their bid to maximise the huge potential of online collaborative partnerships.

Keywords: Online collaborative platforms, Researchers, Research Community, Developing Societies, University communities in Nigeria.

Introduction

Globally, researchers have started to take advantage of the interconnectedness, collaboration and networking capabilities of the Internet and social media in their research endeavours (Yuan et al., 2022). The idea of collaboration in research is fundamental for the interchange of ideas, new knowledge, innovation, and the spreading of research information (Bos et al., 2002). Online collaboration tools now serve as crucial media extending beyond individual researcher's place of residence and affiliation, which hitherto presented challenges for effective partnership. Such collaborative tools include social networking platforms such as Google Scholar, ResearchGate, Zotero, Mendeley, etc. (Proske et al., 2023; Williams & Woods, 2024).

Although the adoption of these online collaborative tools is spreading because of their capabilities to connect researchers from the remotest part of the globe to their counterparts at the other end, there is a dearth of knowledge concerning the effectiveness of these platforms, particularly in

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developing societies (Adeninyi et al., 2024). Research has shown that researchers who are willing to explore the opportunities inherent in the adoption of these tools face enormous barriers, some of which are poor Internet networks and unaffordable price of telecommunication and Internet services, other digital infrastructural problems, low levels of digital literacy (Dodsworth, 2019; Bullinger-Hoffmann et al., 2011) and differing knowledge and opinions about how research should be undertaken (Anandarajan & Anandarajan, 2010).

The current study focuses on Nigeria, a developing country known for its robust and resilient academic community but with limited resources. In Nigeria, lack of funding, digital infrastructural deficit, and erratic electric supply, among other problems, confront the university system (Ibiteye & Emitha, 2023; Uko, 2024), which, in turn, impact negatively on the nation's researchers' capacity to collaborate with their counterparts all over the globe (Igben & Adebayo, 2023). However, regardless of these challenges, academics in the Nigerian space continue to demonstrate commitment towards holistic digital collaboration (Adeniyi et al., 2024; Echezona et al., 2011).

Although academics within the country are rapidly adopting a number of these tools (i.e., Mendeley, Acedemia.edu and Google Scholar) for finding literature and managing references framework relevant to their research at a time, the full potential of adopting these tools is limited as a result of infrastructural problems including limited, slow and often poor internet experience, lack of institutional backing and lack of skills for adopting online collaborative techniques (Adeniyi et al., 2024). In response to the worsening situation, a few Nigerian academics are resorting to self-learning to expand their capacity towards effectively using online collaborative resources (Adeniyi et al., 2024). Consequently, there is a gap in knowledge pointing to the need for more empirical evidence in order to inform context-specific interventions that researchers can adopt in maximising the full potential of engaging with online tools and channels designed for a smooth collaborative experience for researchers.

This study therefore examines the utilisation and effectiveness of online collaborative tools among academics within the universities' communities in Nigeria. Undertaking such a study within the context of Nigeria is significant because it allows for a broadening scholarly understanding of the challenges and the possible pathways to ensuring effective recommendations that could address these challenges.

Literature Review

Extent of Use and Factors Influencing Online Collaboration Tool Usage among Researchers

Numerous studies have been conducted on the extent of the use of online collaborative tools, with many focusing on the facilitators and barriers that contribute to their effective utilisation (e.g., Chen et al., 2018; Rangaswamy & Babu, 2021). However, much of the research in this direction has uncovered that researchers have mainly utilised these tools for reference and citation

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management, leaving out an important area, which is networking with fellow researchers from different places, specifically before, during and after research endeavours. As an example, evidence exists showing how these tools have particularly been adopted to manage referencing and bibliographic databases (e.g., Adeniyi et al., 2024; Chen et al., 2022).

Nevertheless, the satisfaction derived from using these tools has been highlighted as a motivating factor for their adoption. In their research Rangaswamy and Babu (2021) and as well as Melles and Unsworth (2015) have found that a major contributor to the use of Mendeley and Zetero in any form was ease of use. Regrettably, very little is known with regard to how these tools can support collaboration that goes beyond an academic's immediate environment and those. Adeniyi et al.'s (2024) finding supported the claim as it was shown that a sample of Nigerian academics demonstrated impressive awareness of these tools (Academic Social Network Tools [ASNTs] such as ResearchGate) which was used for academic information sharing but could only use it for promoting their research publication presence and expanding their reach; instead of engaging in a more holistic collaborative practices beyond their immediate environment. In addition, studies like that of Subaveerapandiyan et al. (2023) have highlighted similar gaps in Zambia.

Other studies have also shown the impact of other critical factors on the adoption, utilisation and effectiveness of online collaborative tools. For instance, barriers relating to poor and limited technological capabilities (i.e. erratic and poor Internet services) have been linked to ineffective digital or electronic collaborations among researchers (Speare, 2018; Adeniyi et al., 2024), with particular emphasis on technological limitations influenced by lack of institutional capacity found in samples from Greece (Melles & Unsworth, 2015) and Indonesia (Rochim et al. 2016). Related challenges to those of technological capabilities also include issues of software compatibility and an increasing data subscription cost (Melles & Unsworth, 2015; Nitsos et al., 2022). In the case of the present research, the depth of the Internet and other technological barriers are most often understood when compared with what is obtained among researchers in developed societies (Adeniyi et al. 2024).

Effectiveness of different online collaboration tools among researchers

Research on the effectiveness and experiences of online collaboration among researchers is extensive and might be contextual. As an example, Mwapwele and van Biljon (2021) conducted a survey on a South African sample. Findings demonstrated the impact of demographics on the effectiveness of online collaboration among researchers in the field of Information, Technology, Communication and Development (ITCD) in the country. Findings also revealed that men and young people between the ages of 25 and 34 used available online tools effectively. Equally, linguistic diversity was associated with the effective use of available online tools.

Similarly, Tarun (2019) investigated the effectiveness of specially designed collaborative tools for student-teacher interaction was investigated. Tarun's findings showed that students in their first

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year perceived these tools as efficacious relative to their seniors. The interpretation of the author suggesting that the demographic variation in the understanding of effectiveness is borne out of technological expectations and experiences indicates that technological familiarity plays a role in gauging effectiveness. In yet another study, Hackett et al. (2023) measured the effect of a collaborative online international learning (COIL) tool on intercultural competency using a quasi-experimental design among undergraduates. Hackett et al.'s findings demonstrated the effectiveness of the tool on intercultural competency as international experiences and cultural differences of the students influenced it.

In summary, the studies that have so far been reviewed indicate that while the use of these tools has been established, the dynamic nature of the effectiveness can best be understood across various contexts, such as demographics, prior experience, and cultural variables. To this end, a major lacuna that seems to exist is the lack of focus on the depth and extent of daily use being linked to actual effectiveness. In other words, understanding the impact of heavy or non-heavy usage might present extended outcomes in research efforts. To that effect, the present research aims to address this gap by particularly focusing on the Nigerian context.

Therefore, in guiding the present study, the following research objectives are developed:

Based on the above review, the following research questions are presented:

1. To what extent do researchers in Nigerian universities use online collaboration tools in their research endeavours?
2. What are the existing barriers to using online collaboration tools among researchers?
3. What differences exist between heavy and non-heavy researchers in their utilisation of various online collaborative platforms for research endeavours?

Theoretical Framework

The theory of diffusion of innovations (DOI) is used to guide the study. The theory's emergence is attributed to Everett Rogers in 1962. The theory provides the basis for understanding the spread of novel ideas as well as technological advancement within a social structure (Rogers, 1962; Roman, 2003). Some key basic principles drive this phenomenon, according to Rogers. These include characteristics of innovation or idea, the channel adopted for spreading the idea, the period under which the innovation is manifesting and the social structure in place at that time (Rogers, 2003; Rogers et al., 2014). In addition, the theory highlights five key features through which innovations manifest: observability, trialability, complexity, compatibility and relative benefit (Rogers, 2003; Rogers, 1995), particularly in terms of speed and prevalence.

The theory is relevant to this study in that it possesses the capacity to offer explanations into how online collaboration tools are adopted among researchers within the Nigerian academic community. For example, the theory could explain why tools such as Mendeley, Zotero, etc, are

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perceived to be more effective compared to others, highlighting the significance of relative advantage, compatibility, triability and observability in the adoption process. The theory can also help to explain how communication channels (i.e., ResearchGate, Zotero, Mendeley) and social systems (community or network of researchers and its attendant characteristics such as age, gender, training gaps and limited internet access) affect the adoption of online collaborative tools, which all constitute part of the key components of DOI.

However, the theory has been critiqued for generalising the existence of a reasonably homogenous adoption population that acts rationally, which is seldom the case in real-world instances (MacVaugh & Schiavone, 2010). Regardless, the theory's significance in the world of technological diffusion innovation remains profound, as it offers a robust foundation for how innovations spread within a social system.

Methodology

Research Design

We used an online survey method to elicit data from Nigerian academics across several universities in the country. Online surveys are popular within the academic community for a number of reasons. First is its capacity to reach a population or samples that are considered widespread, hard to find, and or secretive (Singh & Sagar, 2021). Second, it is relatively cheap and rapid in eliciting data over a short period (Wright, 2005). As a result, the design is suitable for eliciting data from academics scattered across various Nigerian universities who are also likely to be experienced in using online collaborative tools for their research endeavours.

Sampling and Recruitment

We recruited a total of 312 academics that we identified and approached through a combination of purposive and chain referral (i.e., snowballing) sampling techniques (Creswell & Plano Clark, 2017). The combined sampling approaches made it easy and quick for us to find the purpose set of researchers as they mostly came from reliable sources through referral. However, a small portion of respondents were first selected based on their repertoire of online publications and membership in online platforms designed for research dissemination and collaboration (e.g., ResearchGate, Mendeley, Zotero, among others). Before the data collection period, we obtained ethical approval from the University of Nigeria, Nsukka. The sample of respondents were diverse with an average age of 38 years (SD=6.2), and a slightly higher proportion of men (58%) compared to women (42%). They also represented various fields and disciplines.

Measures

In designing the data collection instruments for the study, we developed a set of questionnaire headings (i.e., [1]Tool Preference and Usage Frequency, [2]Perceived challenges, and[3]Perceived

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Effectiveness of Tools), and later tested their reliability following data collection. For clarity, the first set of questions (5) elicited data on actual preferences and use of tools such as Google Scholar, Mendeley and Zotero on a 5-point Likert scale ranging from "Never"=0 to "Very Frequently"=4. We also collected data on challenges faced by researchers that were elicited using a 7-item (statements relating to limited internet access, data security, etc) across a five-point Likert Scale ranging from "Strongly Disagree" = 1 to "Strongly Agree" = 5. We elicited Information on the perceived effectiveness of tools between heavy users and non-heavy users, using a response category ranging from "Not Effective at all" = 0 to "Very Effective = 4". Heavy users and Non-heavy users were also categorised based on their perceived preference and extent of use of these various tools. The Chrobach's alpha results for the individual scales were highly reliable: ([1] Tool Preference and Usage Frequency = 0.76, [2] Perceived challenges = 0.82, and [3] Perceived Effectiveness of Tools= 0.72) as does the overall scale (0.79). Furthermore, we conducted the face validity of the instrument by involving experts in the field of Information and Communications Technology (ICT) to examine and provide feedback concerning the items contained in the data collection tool. This was informed by the position of Sangoseni et al. (2013), emphasising the significance of face validity in research. We acted appropriately upon the feedback provided by the experts, and this assisted the development of a validated instrument.

Data Collection

At the start of the survey, we shared an online survey link with respondents who were initially identified, and they went ahead to share it with other respondents. The capacity of this method of survey in reducing the cost of data collection made it appropriate for adoption. We elicited data over a period of 21 days.

Data Analysis

We performed data analysis using descriptive and inferential statistics. First, we summarised data using proportions and central tendency measures (CTM) to describe it. We also used independent samples t-test, ANOVA, and linear regression to establish differences and relationships among variables of interest. We employed SPSS Version 26 to manage and analyse the data.

Result

Preferences and Frequency of Usage of Online Collaboration Platforms

Table 1: Key Preferences and Frequency of Usage of Online Collaboration Platforms

Online Collaboration Tool	Number of Users	Percentage of Total Respondents	Frequency of Use (Mean)	Standard Deviation
Google Scholar	132	42.3%	4.5	0.7
Mendeley	94	30.1%	4.2	0.8

DOI: https://doi.org/10.5281/zenodo.13208653EISSN: 2735-9891

Zotero	64	20.6%	3.8	0.9
Other Tools	22	7.0%	3.0	1.2
Total	312	100%	-	-

The summary of data in Table 1 regarding the researcher's preferences and frequency of usage of online collaboration platforms revealed that Google Scholar is the most used platform (42.3%), with Mendeley (30.1%) following. Some 20.6% of researchers mentioned that they use Zotero, while others (7.0%) said they used other platforms (i.e., Zoho, Figshare, Etherpad, etc). A similar trend was also noted in the frequency of use by the researchers. For instance, Google Scholar (M= 4.5, SD= 0.7), Mendeley (M= 4.2, SD= 0.8), Zotero (M= 3.8, SD= 0.9) and other tools (M= 3.0, SD= 1.2) were used very often and scoring high in their mean output. Overall, researchers in the sample have a high preference for and frequent use of these platforms.

Challenges Faced by Researchers in Using Online Collaboration Tools

Based on the data on challenges identified by researchers (see Table 2), it was shown that limited access to Internet services (M=3.7, SD=0.9) presented with the highest mean score and followed by software compatibility issues (M=3.3, SD=0.8), training and skill deficiency (M=3.2, SD=0.6), data security concerns (M=3.1, SD= 0.7), absence of institutional support (M=3.0, SD= 0.7), high cost of software subscription plan (M=3.4, SD= 0.6), and difficulties using/managing different tools/platforms (M=3.6, SD= 0.5). Overall, the findings highlight all of the above challenges as critical, serving as barriers to effectively utilising online collaboration tools.

Table 2: Challenges Faced by Researchers in Using Online Collaboration Tools

Challenge	Mean	Standard Deviation (SD)
Limited access to Internet services	3.7	0.9
Software compatibility issues	3.3	0.8
Training and skill deficiency	3.2	0.6
Data security concerns	3.1	0.7
Absence of institutional support	3.0	0.7
High cost of software subscription plan	3.4	0.6
Difficulties using/managing different tools/platforms	3.6	0.5

Users and Non-heavy Users of Online Collaboration Tools

Table 3: Users and Non-heavy Users of Online Collaboration Tools

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Group	Mean (M)	Standard Deviation (SD)	t-value	p-value	Effect Size (Cohen's D)
Heavy Users	4.6	0.5	7.75	<.001	1.27
Non-Heavy Users	3.9	0.6			

We conducted an independent samples t-test to ascertain whether there is a statistically significant difference in the mean scores of perceived effectiveness between heavy and non-heavy users of online collaboration tools. Findings revealed a statistically significant difference between groups(t[310]=7.75, p<.001), with the heavy users (M=4.6, SD= 0.5) scoring higher in terms of effectiveness compared to the non-heavy users (M=3.9, SD- 0.6). A Cohen's D effect size was calculated, and the output indicates a large effect size (1.27)between the groups.

Perceived Effectiveness among Different Online Collaboration Tools

Table 4: ANOVA Results - Perceived Effectiveness Among Different Online Collaboration Tools

Platform	Mean (M)	Standard Deviation (SD)	F-value	p-value	Effect Size (η^2)
Google Scholar	4.2	0.6			
Mendeley	4.6	0.4			
Zotero	4.0	0.7			
Other Tools	3.6	0.9			
ANOVA Results			15.69	<.0001	0.27

To ascertain the differences in mean perceived effectiveness across tool/platform types, we performed a one-way Analysis of Variance (ANOVA) test. As shown in Table 4, findings from the ANOVA test revealed a statistically significant difference in mean perceived effectiveness across tool types (F (4, 308)= 15.69, p<.0001). The effect size, analysed as eta squared (η^2), was 0.27, suggesting a large effect size. According to Cohen's (1969, as cited in Richardson, 2011) guidelines, partial eta-squared (η^2) effect sizes were evaluated as follows: 0.01 representing a small effect size, 0.06 suggesting a medium effect size, and 0.14 indicating a large effect size. A closer look into the individual mean perceived effectiveness scores also showed that Mendeley (M=4.6, SD= 0.4) had a higher score compared with Google Scholar (M=4.2, SD= 0.6), Zotero (M=4.0, SD= 0.7), and other tools (M=3.6, SD= 0.9).

Demographic Characteristics, User Group, and Frequency of Tool Usage as Predictors of Perceived Effectiveness

DOI: https://doi.org/10.5281/zenodo.13208653EISSN: 2735-9891

Table 5: Demographic Characteristics, User Group, and Frequency of Tool Usage as Predictors of Perceived Effectiveness

Predictor	Beta (β)	p-value
Age	0.10	0.04
User Group (Heavy vs Non-Heavy)	0.52	<.01*
Frequency of Using Tool	0.55	<.01*
Gender	0.01	0.18
Model Summary		
F-value	37.82	<.000**
R^2	0.25	

Note: * = significant at .05, **= significant at .001

We conducted a linear regression statistic to determine the effects of researchers' demographics frequency of the use of online collaboration tools on perceived effectiveness. As summarised in Table 5,we found that the overall regression model ($F[4, 307]= 37.82$, $p<.000$) accounted for 25% ($R^2 = 0.25$) of the variance explaining the perceived effectiveness of adopting online collaboration tools and showing that the predictors included in the model had a substantial impact on perceived effectiveness. More specifically, age ($\beta= .10$, $p=.04$), user group (heavy user vs non-heavy user) ($\beta = .52$, $p<.01$) and frequency of using a tool ($\beta = .55$, $p<.01$) correlated positively and significantly with perceived effectiveness. Nonetheless, gender did not predict perceived effectiveness ($\beta = .01$, $p=.18$). Overall, findings highlight the significance of user group, age and frequency of using tools in understanding the use of online collaborative tools among the sampled researchers.

Discussion of Findings

We examined the utilisation and effectiveness of online collaboration tools among researchers in a Nigerian sample across several universities. Analysis of data has shown various outcomes that are worthy of discussion. First, findings showed a high preference for many of the platforms presented to respondents, with Google Scholar being the most frequently used, followed by Mendeley and Zotero. This finding is consistent with extant research showing the dominance of Google Scholar, which was attributed to its widespread database and search capabilities (Rangaswamy & Babu, 2021). The same dominance was highlighted in studies like that of Chen et al. (2018), showing the most preference for Mendeley because of its capacity to manage references and other collaborative features.

We further found common challenges that researchers face when using these online collaborative tools. They are limited access to Internet services, software compatibility issues, training and skill deficiency, data security concerns, absence of institutional support, high cost of software subscription plan, and difficulties using/managing different tools/platforms. Similar findings have

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been noted in previous studies indicating the influence of technical challenges and infrastructural problems on effectively utilising online collaborative tools among researchers across different samples (Adeniyi et al., 2024). Equally, issues that were raised in the present findings concerning the barriers to software compatibility and the high cost of data subscriptions are reflected in studies elsewhere (Nitsos et al., 2022; Melles & Unsworth, 2015). Moreover, the emphasis laid on Internet challenges further supports the position presented by Adeniyi et al. (2024), which highlights the gravity of the Internet digital divide between developing and developed countries, which is also impacting the potential for collaboration across both categories of countries.

In addition, findings from the present study showed that the level of engagement, as defined by heavy use and non-heavy use, impacted the perceived effectiveness of these tools. Specifically, heavy usage had a greater impact on perceived effectiveness relative to non-heavy usage. As Tarun (2018) has argued, for such tools to be considered effective, users must engage with them more often.

We also observed significant variances across various platform types in terms of perceived effectiveness. Specifically, Mendeley was found to be mostly effective compared to other platforms. This finding is consistent with a study elsewhere showing the significance of Mendeley usage on the accuracy and referencing management and citations in an Indonesian sample (Sulaiman & Patak, 2019). The present result confirms and extends knowledge in this area as it indicates how preference for a particular platform can influence researchers' perceived effectiveness.

Finally, the regression analysis showed the influence of user group, age and frequency of using tools on perceived effectiveness. These outcomes are related to those in extant research. For instance, a study showed that online collaborative engagement was more effective among younger researchers compared to their older counterparts (Speare, 2018). The positive relationship observed between the user group and the frequency of tool utilisation and perceived effectiveness highlights the significance of always improving on use in order to maximise user experience (Hackett et al., 2023). Put together, the findings can assist in informing intervention direction, particularly in developing training pathways for academics and researchers to be able to function effectively in the world of digital collaboration (Rochim & Sari, 2016).

Implication of Theory for Findings

The DOI theory adopted in this study also shares some fundamental basis with what we found in several instances. As an example, the DOI theory argues that innovation permeates through the social space depending on features such as perceived relative advantage, compatibility with current practices, complexity, trialability, and observability (Rogers, 2003). Therefore, the differences in preferences for Mendeley in terms of effectiveness compared to other platforms can be interpreted as a reflection of compatibility and relative advantage, for instance. Researchers' common usage

DOI: https://doi.org/10.5281/zenodo.13208653EISSN: 2735-9891

of Google Scholar can also be described as relating to the concept of observability, suggesting that the platform is probably more visible to the researchers in the sample. In addition, highlighting the influence of these barriers observed in the findings can be reflective of characteristics of the social system, which DOI believes influence the acceptance and rejection of technologies. Overall, the principles of DOI have further been confirmed in the present research.

Conclusion

Overall, the current research highlights the significance of developing evidence-based strategies to address the key barriers to effective online collaborative tools utilisation among Nigerian researchers and in places that share similar challenges with the present context. Therefore, focusing on building technical strategies to address Internet challenges, training and skill deficits, and software compatibility is a good way to start changing the status quo. It is also important to note that interventions, based on the current findings, can be informed by demographic realities and attitudes towards technology. Also, institutions must develop more digitally conducive spaces and partnerships with more of these platforms for researchers to maximise the vast opportunities within the online collaborative space.

Limitation

As with other studies, this research is not without limitations. A major weakness of this research endeavour is our dependence on self-reported data, where respondents might not haveaccurately presented their experiences. This can negatively impactour findings' external validity, particularly beyond a wider sample or academic communities in Nigeria and beyond. On the other hand, the reliance on a survey might have impacted the possibilities of uncovering nuanced experiences and viewpoints on the subject matter of the research. Regardless of these shortcomings, the present study has produced unique insights into online collaborative adoption among researchers. Based on the above, future studies could adopt mixed methodology or qualitative approaches (i.e., Interviews or focus group discussions) to expand various possibilities regarding outcomes.

Recommendations

Following the findings elicited from the study, we recommend that specific or customised interventions should be developed to address challenges researchers face in their bid to maximise the huge potential of online collaborative partnerships. In specific terms, strategies can include expanding and strengthening internet infrastructure in institutions nationwide. Access should also be improved and encouraged through subsidies for academics, especially when they are outside the institutions for research work. It is also important that institutions provide training programmes and sessions to improve research skills and equip them to realise the full possibilities embedded in the online collaborative space.

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